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The Interplay between Green IS Affordances and Organizational Capabilities in the Creation of Business Value

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Abstract

This paper explores how functional affordances vary across multiple organizations that implemented the same green IS. Using a model that draws on stakeholder and other theories we conducted a multi-case study of four organizations to explore the differences in benefits that are realized based on the affordances that are perceived by the users and managers in each case. Using the tasks and goals identified by the implementers for use of the system, we identified four green IS functional affordances across the cases, not all perceived in all cases, nor exploited similarly. The four are based on the features of the BAS that enable connectivity to, and configuration of the digital control systems of building equipment, as well as monitoring (data provision) of the equipment operations. We describe them as: centralized equipment configuration and access -- opportunity to configure set-points for, and to access data from, multiple equipment control systems using a single device/access point; diagnostics/problem-solving -- opportunity to access information related to malfunctioning equipment for resolving problems and address customer complaints; strategic positioning -- opportunity to access information to position the organization to maintain existing leases and to compete for new leases as well as "green" funds; and, environmental awareness and behavior change management -- opportunity to increase tenant awareness and behavior change by highlighting conflicts between demands for indoor environmental conditions and environmental sustainability. Through our work, we provide several contributions, including insights to both researchers and practitioners on the affordances of yet another green IS, the building automation system. We also insights related to the potential types and differences in implementation outcomes that can be realized based on how users approach the systems, particularly in terms of the knowledge of the system, and the goals and tasks users have in mind for the systems.

Keywords

Green IS, IS value, functional affordances, sustainability, organizational capabilities.

Introduction

Information systems (IS) research has recently focused on the natural environment, bringing attention to the solutions that green information systems (green IS) provide to organizations (Malhotra, Melville and Watson 2013). These systems reduce and monitor the harmful natural environmental effects of the processes for which they have been implemented. Nevertheless, it is well known that implementing IS comes with no guarantee of success (Brynjolfsson and Hitt 1998). In fact, we expect that, even when multiple organizations implement the same system, there will be variation in what value is realized based on the features of, and the frequency with which, the system is used. According to Delone and Mclean, in a temporal view of IS implementation, an "IS is first created, containing various features, ... Next, users and managers experience these features by using the system... The use of the system and its information products then impacts or influences the individual user in the conduct of his or her work, and these individual impacts collectively result in organizational impacts" (Delone and McLean 2003) (page 11). In this research, we sought to investigate how variations in the experiences of users and managers with the features of green IS influence the value realized from green IS implementations.

Like many IS value studies, we drew on the resource based view of the firm (RBV) (Wernerfelt 1984) to explain how green IS is used to create value. We also drew the concept of functional affordances (Markus and Silver 2008, Seidel, Recker, and vom Brocke 2013). A functional affordance is defined as the potential uses of IS originating in the system capabilities that identify opportunities for system use, given the system user's

capabilities (Markus and Silver 2008). This definition explicitly identifies roles for both the technology deployed and the user in its use. We argue that IS affordances – opportunities for use -- are

also opportunities for creating value in the execution of organizational tasks that the user performs using the IS, and that, only when users exploit these affordances will performance be improved and value created (Goodhue and Thompson 1995). We therefore believe that exploring differences in the tasks that that users execute, and the IS affordances they exploited in the execution of those tasks, may provide important insights into how organizations that implement the same green IS realize different outcomes.

IS affordances have received little attention in the green IS value literature. More recently, Seidel, Recker and vom Brocke (2013) revealed the availability of four affordances accessed through the implementation of multiple green IS in a case study of a single organization. The research revealed how the affordances enabled sustainability transformation of the implementing organization. A closer look at the transformational effects of the affordances identified reveals outcomes such as reduction in greenhouse gas emissions, the number of physical servers, technology energy usage, and paper consumption per employee -- clearly business value outcomes with triple bottom line effects. However, while the study was clear on the realization of value from the IS affordances, whether and how the IS affordances would vary across multiple organizations implementing the same IS, and what value that would be realized across the various organizations, remains unknown.

This study therefore seeks to take a closer look at affordances provided by implementations of a single green IS across multiple organizations. The goal is to understand how these implementations differ with respect to what green IS functional affordances users perceive and exploit, and how any differences in the affordances identified in the various cases influence the success of the green IS across the cases examined. In our study, we ask the following questions:

1. What green IS functional affordances do users perceive and exploit in each case when the same green IS is implemented across multiple organizations?
2. What explains differences in the green IS functional affordances perceived across organizations?
3. Are green IS affordance outcomes necessarily the same across cases implementing the same system?

To answer these questions, we used the case study methodology to conduct a multiple-case study of a single green IS. We selected the case study methodology because we wanted to perform an in-depth exploration of the green IS implementations -- the functional affordances, and the value realized.

The rest of this paper proceeds as follows. In the next section, we outline our research methods. We follow with the results of our analysis and a discussion of those results. We end with a brief discussion of the implications of our study for future research as well as practice.

Research Methods

We used a model to guide our study; however, we were nevertheless uncertain about the nature of the affordances we would find. We therefore selected the case study methodology to support an in-depth exploration (Corbin et al 2008) of the green IS implementation. This method was particularly necessary to explore the functional affordances and the value realized from them. Although Seidel et al. (2013) reported on green IS functional affordances in a previous study that explored multiple green IS in a single organization, we were not certain that, with a single IS across multiple organizations, the affordances would be the same. We also wanted to know what particular benefits resulted from particular affordances in different implementation scenarios. Based on our goal of comparing affordances and value across multiple organizations, we conducted a multiple-case study of a single green IS.

Research Model

Our research model proposed that information technology capabilities, complemented by organizational capabilities afford opportunities for the IS to be used to improve task performance within the facilities management domain (Serrano et al. 2016,). We defined technology capabilities as the features of our focal IS that provide users with opportunities to improve their task performance within the domain of use -- we describe these opportunities as functional affordances. We defined organizational capabilities as the knowledge and skills of the users that enabled them to identify and exploit the opportunities provided by the IS.

As has been found in green IS studies (Simmonds et al 2013, Simmonds et al 2015, Watson et al 2010), business value from green IS now extends to benefits to organization employees and other key stakeholder groups, and the natural environment -- the triple bottom line benefits (Elkington 1998).

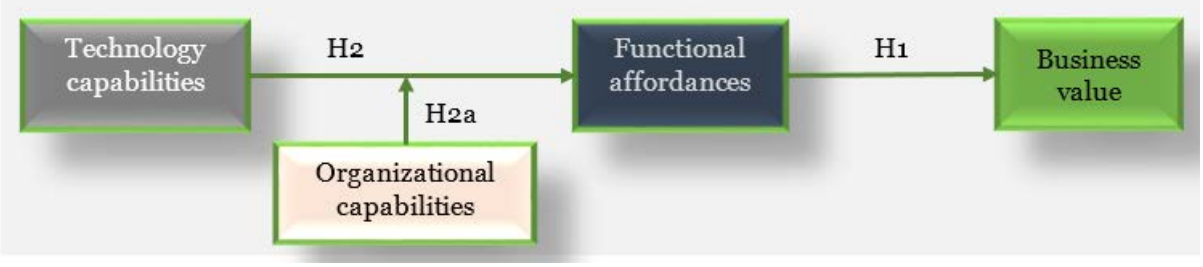

Figure 1: Research Model

Stakeholder theory (Freeman 1999) also supports this idea of a multi-stakeholder outcome. We therefore sought these specific outcomes in our study. Figure 1 below depicts our research model.

Data Collection

Our study was focused on a specific IS – our goal being to investigate how affordances and value possibly differs across cases. Therefore, our sample included a set of organizations that had (necessarily) implemented our focal green IS. Our focal green IS was the building automation system (BAS), implemented by organizations to monitor building indoor climate and control operational costs. Several types and components of equipment can be connected to and through the BAS; however, the most common are those associated with heating, ventilation and air conditioning (HVAC) and as well as lighting equipment. These two have been to found to account for approximately 80% building energy consumption (Kowoforola and Gheewala 2009). We therefore focused on organization teams that worked routinely with this IS.

We used interviews for data collection. We conducted these with members of facilities management teams of the organizations we studied. Three members of each organization were interviewed – one building engineer, a supervisor, and a manager. We explored the IS affordances by examining the tasks that each member conducted within the domain. Therefore, having interviewed this range of personnel we were able to access a wide range of user experiences. Overall, we interviewed teams from within four organizations.

Data Analysis

We analyzed our cases at the organizational level. Functional affordance was the source of value in or investigation. We used the tasks enabled by the system as the basis on which we identified and differentiated between IS affordances across the various cases we explored. Serrano et al (2016) demonstrated how the fit between uesrs, tasks and the IT created improved task performance (value). Our procedure was such that we first performed individual case analyses, and then across-cases analysis. This gave us the opportunity to perform abstraction across the team members and then cases in order to determine the affordances and value as well as obtain an overall picture of the user experiences with the green IS. We started with open coding of our data, guided by our model. Therefore, we set up nodes that represented our constructs and relationships and searched the data for evidence of these two sets of model building blocks. We then engaged in axial and selective coding. The steps provided by Corbin and Strauss (2008) guided us in performing these three steps.

Therefore, we first identified, from the data, what major green IS-enabled tasks users performed in each case, and used those to identify the use opportunities the IS provided to team members and organizations. We also analyzed the value that the users realized in each case. We expected that with the single IS, the capabilities would be standard across the cases; however, we expected that there would be some differences in the affordances and value evident in each implementation case.

We report our results next.

Results

Overall, we found evidence in support of our model constructs and relationships. We also identified four BAS affordances. The four are based on the properties of the BAS that enable connectivity to, and configuration of the digital control systems of building equipment, as well as monitoring (data provision) of the equipment operations. Table 1 presents details of the four functional affordances along with examples of tasks or goals that the IS afforded opportunities for team member(s) to realize/execute.

Green IS Functional Affordance	Definition of Green IS Functional Affordance	Example of Tasks/Goals Related to Green IS Affordance from Domain
Centralized equipment configuration and access	This affordance enables engineers to configure, reconfigure and collect and analyze data from a single access point for multiple control systems	Perform site visits to diverse locations to configure equipment and address tenant complaints
Diagnostics/ Problem-solving	This affordance enables engineers to address customer complaints and resolve problems related to malfunctioning equipment. Engineers and managers were also able to analyze trends and determine set-points for improved triple bottom line value	Diagnose and solve equipment issues and tenant complaints. Analyze triple bottom effects of configurations and reconfigure equipment for improved outcomes
Strategic management support	This affordance enables managers to position the organization to maintain existing leases, compete for new leases and "green" funds, and improve administrative task performance. Tenant satisfaction also increased with more accurate measurement of their energy use.	Attain "green" rankings to compete for new leases; compete for "green" funds; and forecast energy for future leases. Customize tenant energy bills
Environmental awareness and behavior change management	This affordance enables tenant awareness and behavior change by highlighting conflicts between demands for indoor environmental conditions and environmental sustainability	Illustration of environmental impact of climate configurations to increase tenant aware-ness and behavior changes

Table 1: Details of Functional Affordances Identified

The four affordances are as follows. The first we named ***centralized equipment configuration and access*** -- an affordance that enabled engineers to access the configure set-points for, and to access data from, the control systems of multiple equipment using a single device/access point. The second we named ***diagnostics/ problem-solving*** -- an affordance that enabled engineers to access information related to malfunctioning equipment for resolving problems and address customer complaints. The third was ***strategic positioning*** -- an affordance that enabled managers to access information for positioning their organizations to maintain existing leases and to compete for new leases as well as "green" funds that were available for buildings. The fourth was named ***environmental awareness and behavior change management*** – and represented an affordance that enabled sustainability personnel to increase tenant awareness and drive behavior change by highlighting conflicts between demands for indoor environmental conditions and environmental sustainability.

Our findings show that all affordances except one – awareness and behavior change management -- were evident across all cases. In terms of outcomes, we found that they mostly resulted in organizational benefits that were peculiar to each case mostly due to the goals of the management of the implementing teams.

Overall, we found that the affordances enabled the creation of sustainable value -- three-dimensional short-term benefits, as well as strategic economic benefits -- for the implementing organizations. The exploited affordances resulted in benefits for the natural environment realized through increased building energy

efficiency as well as reduced employee travel. There were also benefits for the building tenants, particularly greater safety and comfort.

In Table 2 below, we provide exemplary codes extracted from the data. These support the constructs and relationships from our research model.

Construct/ Relationship	Example of Model Item and Code Extracted as Evidence	Related Case/ and Interviewee
Technology features	**Cell alerts (communication)**: *I get the alarms from the system about the air handlers on my cell phone; so if we have a temperature issue, I can retrieve details of those from my cell phones.*	**P2**: Building Engineer
Functional affordance	**Centralized equipment access**: *For Fire Alarms which include smoke and heat detection, we have to know:* • *What's the impact on HVAC? System must close dampers to prevent the spread of smoke to the rest of the building.* • *What's the impact on access? Must open all doors to all sections of the building in the event of fire.* • *What's the impact on elevators? Elevators will go immediately to the ground floor and remain until reactivated.* • *What's the impact on our CCTV? Full recording and media must display alerts that point employees to the exits.*	**P1**: Facilities Manager
Organizational capabilities	**User training and experience**: *My experience is like this -- I started at the largest building in Central Florida – ¾ million sq. ft. with 32 floors and a basement. I worked there. Of course, with a building of that magnitude, you're going to have multiple problems – a great place to learn, and I learned a lot there. Another real estate management firm was managing the building, and in my experience they have some of the best building engineers in the field. I received great training there and that's one of the things that qualify me to do what I do. I have 6 to 7 years using computers to manage buildings.*	**R1**: Building Engineer
Business value	**Reduced labor costs**: *For a building of this nature we would have hired a management company. In the old building, we had such a company. They managed the building and came in and set everything. We had a lot of persons on call just to operate. We eliminated a lot of those. And, moving into this building, we would have had to hire even more persons. Yet we were able to scale back. And the reason for this is that it allows for any one of the engineers to manage the building on their own from anywhere.*	**P1**: Facilities Manager

H1	Evidence of relationships between: **(1) *Equipment reconfiguration & zone management*** and ***Business value*** **(energy cost savings);** and **(2) *Strategic positioning*** and ***Business value*** **(competitive advantage):** *1. Our electric bill has been halved. Usually we run 1upwards of $160,000 to $200,000. The electric bill was halved by the shutdowns, and that, I think, helped us get such a high energy star rating because since 2008 -- that's when we started tracking you know -- our bills are like in half. That's where we can get such a much higher energy star rating than other buildings because they don't have that much of an improvement to be able to get those credits.* *2. About 35% of our building is leased to the TSA – government. We have to be energy star rated to qualify for those leases. That's the way they've written their leases; you have to have an energy star rating. For some persons that's a requirement, for some companies that's a requirement*	**R1:** Facilities Manager
H2	Evidence of relationships between ***technology capabilities*** (centralized and location-based configurations) and ***functional affordance*** (configuration/zone management): *The system is connected to sensors that are out on the floors. Those sensors tell me what the temperature is in that area. We average that to get the average temperature on the floor. Then we can adjust the air conditioning based on what the average temperature is. If we have a set-point that says 73degrees, the system will seek to maintain that. So it will turn on or off the air handler and slow down or increase the speed of air handler based on our needs.*	**R2:** Building Engineer
H2a	Evidence of moderating effect of ***organizational capabilities*** on **value creation**: *When I was hired here, I was hired as a facilities manager, doing small projects like building equipment shutdowns. There has been some talk about using the system reports for energy savings, but we just didn't have the people in place to take on big projects like that at the physical plant down there.*	**P2:** Associate Director (Facilities Manager)

Table 2: Examples of Construct & Relationships Coded in Study

Conclusion

Our research shows evidence that a single green IS implemented across several organizations will have features with the potential to provide the same use opportunities to multiple implementing organizations; however, the organizational capabilities – the tasks and goals set by the implementing teams for the IS – will moderate the impact of the affordances on the outcomes of each organization's implementation. Our study confirmed the propositions set out in our research model; however, the results also modified our initial view of the organizational capabilities necessary for perceiving the affordances of the green IS we explored. In addition to the tasks set to be accomplished/augmented by the green IS, we now understand this construct to include the users goals for the IS as found in Hanelt et al. 2016. In particular, we found that users' goals for the data produced by the IS were particularly influential for the exploitation of the systems for value. We also found a role for other organizational capabilities -- users' knowledge of the system and experience -- in the exploitation of the IS affordances for the creation of value.

This study has the potential to inform future IS research related to green IS task performance, green IS affordances, green IS sustainable value and sustainability transformations aided by green IS. Adding to the knowledge provided by previous studies, our study provides insights pertaining to the green IS affordances of yet another green IS, the building automation system. We also provide details concerning the potential types and differences in implementation outcomes that can occur based on how users approach the system, particularly in terms of their knowledge of the system, and the goals and tasks that they have in mind as they approach the system. Finally, our study provides knowledge of some benefits that users can realized when equipped with the requisite skills and experience for the use of the system.

Our study also highlights the suitability of the case methodology for the exploration of green IS, especially when the implementation context is unfamiliar to the researcher and in the literature. Our use of the case methodology enabled us to explore the functional affordances of the BAS – more knowledge of a green IS that the literature provided little of before now.

Our study also has practical implications. The knowledge of implementations we describe above as being relevant to researchers is also relevant in practice. Organizations investing in IS often wonder about the returns on their investments (Mithas et al. 2011). Our study shows that, while a green IS has the potential of returning many benefits overall, in no single case were all the benefits realized. Rather, each organization, constrained by the limitations of their internal capabilities, failed to recognize the wide array of possibilities that the IS implementation provided. Our study therefore exposes some of these affordances and their potential outcomes so that organizations may gain awareness of what their competitors may be exploiting and following suit, expand the benefits they realize from their own implementations.

The literature on the use of green IS to create sustainable business value continues to be fairly sparse (Malhotra et al. 2013). Many articles that do investigate green IS value still tend to focus on the short-term economic value that organizations can realize from these systems, despite their triple bottom line and strategic potential. This study shows that this focus is true not only in research, but also in practice – we saw this in the goal-setting among our cases of organizations implementing green IS. For example, an affordance such as ***environmental awareness and behavior change management*** was only evident in a single case, whereas ***centralized equipment management*** and ***diagnostics/ problem-solving*** were exploited by all cases with similar benefits realized across the cases – short term economic value. This could be interpreted as organizations having the capability to exploit only the most basic affordances and ignoring those that involve long-term goals and less intuitive task assignments for the IS – those that could yield strategic economic benefits within the domain of implementation, for the entire organization, and for stakeholders such as the natural environment.

This study demonstrates how green IS affordances provide opportunities for increasing energy savings as well as other benefits not related to the environment. As did Høgevold (2011), we also found that green IS affordances can be exploited for increasing the competitiveness of implementing organizations and providing opportunities for generating future revenue. These include positioning for competitive funds that can benefit the sustainability of the organizations' facilities as well as the entire organization. This study also demonstrates how green IS provide affordances that can move organizations "beyond the business cases" to focus on the sustainability of the natural environment and ensure longer term viability for themselves and others (Dyllick and Hockerts 2002).

Future research may involve a quantitative study of functional affordances of other green IS to understand the extent to which the affordances and value outcomes, as well as the research model we developed, are generalizable across systems, domains, user groups and organizations. Future research may also entail the impact of other variables indicated in the findings, for example elements of organizational culture such as the focus on corporate social responsibility.

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